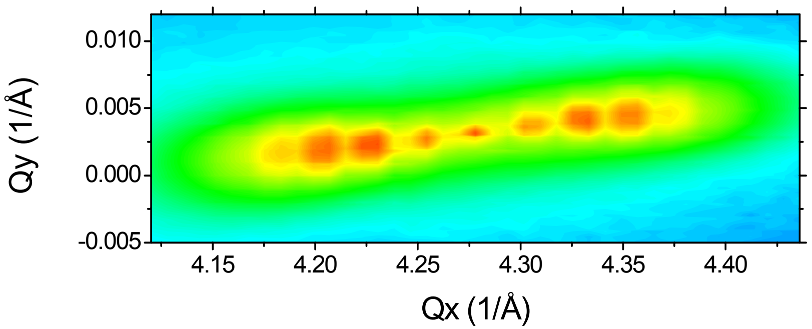
Nanoscale Lateral Structure in Strained $(InAs)_n/(AlAs)_m$ Atomic-Layer Superlattices

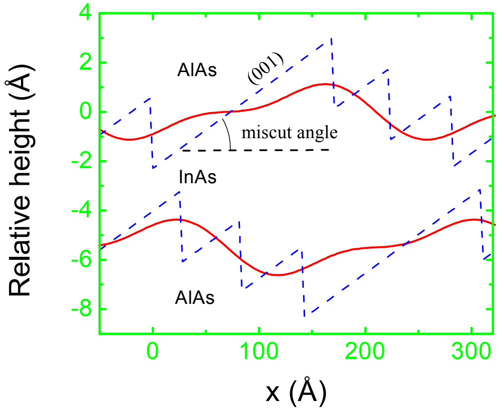
Simon Moss, University of Houston, DMR-0099573

Semiconductor technology continues to influence our lives in a host of ways. As traditional silicon microelectronics approaches its limits, nanoscale semiconductor film structures, which can be self-assembled during the growth process, have attracted much attention for their potential in quantum-electronics. Here we present an x-ray characterization of a laterally structured $(InAs)_{1.5}/(AlAs)_{1.5}$ atomic layer superlattice (the subscript denotes that each individual layer is only 1.5 monolayers in thickness). We show clearly that it is the vertically correlated morphological undulation at the interfaces that results in the nanoscale lateral structure, as indicated by the presence of up to 5 lateral satellites in the x-ray 2D scattering maps. These laterally modulated structures may in turn be referred to as quantum wire lattices with unique electronic properties.

J.H. Li et.al., Phys. Rev. B **66**, 115312 (2002)



Synchrotron x-ray grazing-incidence 2D in-plane diffraction pattern from a self-assembled lateral nanostructure in a $(InAs)_{1.5}/(AlAs)_{1.5}$ atomic layer superlattice



Interfacial structural model derived from our x-ray data. The solid lines represent a continuous model; the dashed lines show the actual interfaces with steps. The undulation of the upper and lower interfaces are out-of-phase, as determined by the synchrotron x-ray experiment.

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Technology

These laterally nanostructured semiconductors have applications in solid-state optoelectronics (polarized light emitters and detectors and lasers) and high-efficiency solar cells. If 3D nano-lattices can be produced as our program proceeds, they may find additional novel applications, such as photonic band-gap devices. It is toward these ends that we have a newly established theoretical program to simulate film growth

Collaboration

With this program, we have established a broad collaborative relationship with the National Renewable Energy Laboratory, the Oak Ridge National Laboratory, the Universities of North Texas and Florida State, the Sandia National Laboratories, Bell Labs, and the Masaryk University, Czech Republic.

The PI with professor V. Holy of Masaryk Univ., Czech Republic, during his work visit at UH in 2002